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AMPUTATION;

An Historical Sketch:

BRING THE SUBJECT OF

THE INTRODUCTORY LECTURE DELIVERED AT NETLEY,
IN COMMENCING THE THIRTY-FIRST SESSION

OF THE

ARMY MEDICAL SCHOOL,

1st OCTOBER, 1875.

BY

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by the
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AMPUTATION.

GENTLEMEN,—It has again fallen to my turn to give the first lecture of the Session. I do not intend to occupy the time with an account of the Army Medical School and its work, or with general recommendations and advice; these topics have been sufficiently often enlarged upon in previous introductory lectures. If you care to know something of the history of the formation, as well as of the several objects of this school, you will find them described in the lecture which was delivered when the school was first opened. This lecture is printed in the first volume of the *Army Medical Reports*. As regards the aims and arrangements of the different parts into which the teaching of the school is divided, these will be explained separately by each Professor at the commencement of his own particular course. And lastly, as regards the constitution of the school, its government, and the manner in which all the duties of the school are required to be conducted, you will each have placed in your hands a book of school regulations, which contains full information on these heads and on various collateral subjects.

I propose to spend the hour allotted to the opening lecture in laying before you the history of a familiar surgical operation—one of the most common, unhappily, in military surgery. And in using the term “military surgery,” I do not intend to restrict the meaning to that which is commonly given to it—surgery in relation to armies operating on shore; but I use the word “military” in its more classical and extended sense—viz., relating to warfare in general, whether conducted on water or on land.

The operation I am about to speak of is amputation of a limb, or of part of a limb. It is, as I have just said, one of the most common operations which a military surgeon has to perform in time of war; especially in the present day, when the mischief done by rifle projectiles to the bones of limbs which happen to be struck by them, is usually so great that no resource is left—at least, none in the majority of instances—but removal of the injured parts by operative interference. The manner in which this operation was

performed in remote times, and the successive improvements made in the performance of it down to the present time, will form the chief topics of my remarks; and I hope that the survey, with the comments which it will lead to, may not be without some points of interest as well as instruction.

When we regard the performance of an amputation, we can scarcely believe that any surgical proceeding can be simpler. We can hardly understand that there can ever have been any difficulty about it. It is evident that no particular knowledge of anatomy is required in mere dismemberment, in which every anatomical structure that is brought in opposition to the knife and saw has only to be cut across. It is easy to see that one surgeon may perform the amputation more quickly, more expertly than another; that if it be a flap amputation, without due care the flaps may be a little too short or too long; if a circular operation, the division of the skin and layers of muscles may be ill or well done, leaving the stump well or indifferently covered; that the bone or bones, from want of due caution, may be unevenly sawn or even splintered; but these and some similar circumstances of minor importance, all quite under the control of ordinary handicraft and care, being excepted, it seems as if the cutting off a limb might and would have been done in the very earliest times of surgical art as readily as it is now done.

How far from the truth would be such a supposition you will see, when I point out some of the difficulties which the ancient surgeons had to contend against in amputating a limb; when I quote from surgeons of comparatively modern periods of time their descriptions of the mode of performing the operation; and when I shew you, lastly, that it is really only within comparatively recent dates that it became possible for an amputation to be done, and for the wound left by it to be healed in the manner which is now common among surgeons of the present day.

The earliest plan adopted for the removal of a portion of a limb which had been subjected to destructive crushing injury, was, as far as is known, to leave the limb until the crushed parts became gangrenous, and then either to cut through the mortified portion, or to allow it to drop away spontaneously. Hippocrates, writing in the fifth century before the Christian era, has left on record that in cases of *fractured* limbs which became gangrenous, his practice was not to amputate, but to wait till the gangrened portions dropped off, which he says they will do quickly, as the bones have yielded beforehand (are already separated); while in a case where gangrene occurred from any cause without a bone or bones having been fractured, then, as soon as the parts were quite dead and had become insensible, he removed the limb at the joint below

the insensible parts, leaving the dead soft tissues and bone above to separate of their own accord.* In short, as to the first class of cases, he left them entirely to Nature; while in the second, he so far interfered as to remove the gangrened limb at the part at which the division could be most readily and most speedily made—viz., at a joint. Care was to be taken not to inflict any wound in effecting this removal, which evidently means that no part still alive was to be divided; for, he adds, if you cut through a part still alive and painful, there is great danger of present death from syncope. No one, as far as I am aware, has found among the most ancient surgical writings any indication of a part of a limb having been cut off from the human body, excepting when that part was absolutely in a state of gangrene, when, in short, it was already dead.†

To what circumstance must we attribute this mode of dealing with such injuries? for, although Hippocrates says that under it most cases of gangrene after fracture recovered, though less so when the fracture was situated on the thigh or arm, than when it was on the forearm and leg, and though he refers to a case where the mortified leg was removed at the knee-joint on the twentieth day, and in which the dead portion of the thigh spontaneously separated on the eightieth day, we know that such a mode of proceeding must have been followed by the death of the patients in all but very exceptional instances. We need not search far to discover the cause of the ancient surgeons amputating only through parts already mortified. They dared not cut through a living part, for they knew not how to stop the flow of blood which would have followed the operation. They could cut through a mortified part without fear, for experience had taught them—observation of the spontaneous separation of mortified parts—natural amputation—had taught them, that this could be done without a rush of blood following it. We understand why this is so; they knew the fact, without knowing the cause.

You are all well aware of the horror which is universally excited by the sight of a wound from which blood is gushing forth in streams, when the bystanders are ignorant of the means of stopping it. There is perhaps no spectacle that causes a more overpowering

* *The Genuine Works of Hippocrates*, translated by F. Adams, London. Sydenham Socy., 1849. Vol. ii., p. 639.

† It is quite evident that among the ancient surgeons there was no notion of amputation as a set operation, such as we regard it at the present day. There was no cutting with a view to leaving a stump at a particular part, or to fashioning it of a certain shape. The word used by Hippocrates is ἀφαιρέειν, and the idea seems to be simply what this word expresses—to take away. What was kept in view was only the removal of something which had become not only useless but deleterious to the patient.

shudder, that creates greater consternation and confusion among a crowd of people, than that of a person rapidly sinking from hæmorrhage in consequence of an accidental injury. Even among educated surgeons, when cases of sudden, severe, copious hæmorrhage occur, and the source of bleeding is out of reach or surgical control, the spectacle is a sufficiently dreadful one.

We may judge, then, what must have been the position and feelings of the ancient surgeons in regard to performing the amputation of a limb, when they knew no more how to stop the flow of blood from a large vessel when divided, than the most uneducated and ignorant person in a chance-collected crowd of the present day. They were probably well aware of the large size of the vessels supplying the limbs with blood, of the large quantity of blood which would pour from them; for designed and accidental wounds in men, and the slaughter of animals, must have taught them these facts. Moreover, from not knowing the true nature or functions of arteries, from finding them after death empty, they were under the impression that there escaped from these vessels some aerial fluid of vital importance, something which they designated animal spirits, the loss of which led to syncope and death, as well as the loss of blood from the veins. We find this idea constantly recurring in surgical writings, until Harvey's investigations put the knowledge of the circulation of the blood on a thoroughly correct basis. How then could they voluntarily assume the responsibility of cutting through these vessels, of letting this blood and these animal spirits flow, when, once set in motion, they knew no means of stopping them? They must have recoiled from the attempt with terror. To have performed an amputation, as surgeons, with complete power of controlling hæmorrhage, now perform it, would have been regarded by them, with no such power, as little else than a deliberate infliction of death. We cannot help wondering that the means of stopping the flow of blood, which appear to us so simple and so obvious, should not have occurred to them; we may wonder still more that many further centuries should elapse before it should be discovered; but so it was. The ignorance is the more to be regretted, for among all the things that were unknown in surgical art, there is probably no one thing which did more to prevent its progress, than this fear of causing bleeding from not knowing how to check or arrest it.

So long as this ignorance lasted we can trace but little essential improvement in the method of amputation. Obviously surgeons were not satisfied with the Hippocratic mode of removing even gangrened limbs; for various views were subsequently held as to the propriety of cutting through the mortified parts, or between them and the sound parts, or making division at a joint or through the

continuity of the bone. Celsus, writing at the beginning of the Christian era, distinctly states that the section should be made between the dead and the living parts, and that it ought not to be made through a joint, but through the shaft of the bone. Although we fail to see the same advance in the subject of amputation which we find in several other branches of surgery in the Augustan age, still this indicates a very considerable advance in surgical boldness as regards the operative part of amputating a limb. Celsus, like Hippocrates, only speaks of amputation, however, being done in cases where a limb has become gangrenous. His description of the mode of performing amputation, though brief, is so precise and clear that I will translate it to you. You will not fail to notice the hesitation with which he approaches the sound parts by the knife, and the fact that he thinks it necessary to make an excuse for performing amputation at all, so frequently does fatal hæmorrhage result from it.

"I have said in another place," Celsus writes,* "that when gangrene occurs in any part of the upper or lower extremities, and healing remedies are of no avail, the limb ought to be cut off. But this also is done with extreme peril, for often during the operation itself death takes place either from hæmorrhage or syncope (*sœpe in opere ipso, vel profusione sanguinis, vel animæ defectione moriuntur*). It ceases to be a matter of concern, however, whether a resource is safe enough when it is the only one."

"The flesh, then, should be incised by a scalpel between the sound and diseased part down to the bone, in such a way that it is neither done against a joint, and that rather some of the healthy part should be cut away, than any of the diseased part left." (It is evident that he means the mere surface of the sound part to be removed.) "When the bone has been reached the sound flesh should be drawn back from it, and should be cut under around the bone, so that at that part also the bone should be laid bare; it should then be cut away by a saw as near as possible to the sound flesh which is adhering to it; and then the front of the bone, which has been scored by the saw, should be washed, and the skin brought over from above. The skin under this method of cure ought to be lax, so that it may cover the bone from all sides as much as possible. The parts over which the skin shall not have been brought forward will be covered by lint, and sponge steeped in vinegar should be fastened over it. The rule is that the after treatment shall be the same as that which is followed in wounds in which suppuration should be promoted."

During the fourteen hundred years and upwards which passed between the time when Celsus wrote this description of amputation and the discovery of ligaturing the divided vessels to stop the flow of blood from them, the probability seems to be that in the greater number

* Book vii., Art. 33.

of cases the mode of amputation described by Celsus was the practice which was chiefly followed. Other modes of amputation are referred to at intervals during this long period. At one time mortification was recommended to be induced by bandaging a limb with great tightness, and then the mortified part was to be allowed to separate naturally, or was to be removed by the knife. Amputating through the sound parts with red-hot knives is said to have been practised at one time. The application of cauterising irons to stumps to check the bleeding, was a common practice. The eschar thus formed would probably stop the bleeding for a time, on the same principle that modern surgeons occasionally employ the actual cautery and galvano-cauterics as hæmostatics in situations where it is not convenient either to ligature or compress bleeding vessels; but we can easily imagine that when the divided vessels were the larger trunks of a limb, the arrest could seldom have been permanent. Another plan referred to is dipping the end of the stump immediately after the amputation in boiling pitch.* That none of these modes was found satisfactory in practice is sufficiently evident from the fact that Guy de Chauliac, of Montpellier, a surgeon of very high repute, and perhaps the most learned surgical author of the fourteenth century, in his chapter on amputation, recommended, on a limb becoming gangrenous, that the sound parts above should be scarified and covered with defensive applications to arrest the spread of the gangrene, while the mortified part should be enveloped in a sort of embalming plaster, and allowed to separate of itself, rather than be removed by the knife. It was almost reverting to the plan of Hippocrates.†

Let us turn now to the period, about the middle of the sixteenth century, when the important discovery, by Ambrose Paré, of the mode of stopping hæmorrhage by tying the end of the bleeding vessel with a ligature was to be made. What I have just mentioned to you of some of the modes of amputating in vogue will give you a fair idea of the saving of torture and of life this invention was destined to effect; but we have the means of still more vividly shewing the importance of the invention, by studying the directions for performing the operation which were given in Germany at the very time the invention of the ligature was made in France. Hans

* Professor Spence, in the Address on Surgery before the British Medical Association, in August last (1875), mentioned that he had seen a man who had undergone amputation of the thigh, in whose case hot pitch had been applied to the face of the stump after the operation to arrest the bleeding. The man made a good recovery. See the report of Professor Spence's Address in the *British Medical Journal* for August 14, 1875, No. 763, p. 193.

† An account of Guy de Chauliac and his writings may be seen in the Introduction, by Malgaigne, to his edition of Ambrose Paré's works. See also Haeser's *Lehrbuch Der Geschichte der Medicin*, &c. Jena, 1868, vol. i., p. 354.

von Gerssdorff, a surgeon of much military experience, was a contemporary in Germany of Ambrose Paré in France. Here is his book, printed in 1551, in which he gives instructions on the mode of performing an amputation.* These instructions are supplemented by drawings of the instruments used in performing it, and also by an illustration of a surgeon in the act of amputating a leg.

The commencement of his directions is serious enough, and sufficiently indicates the improbability of the happy issue which he promises:—

“First, order the patient before all things to commend himself to God, to confess his sins, to reflect on the sufferings of Jesus Christ with thankfulness; and let the surgeon do the same, and God will give a happy issue to his undertaking.”

The next direction is one which is quite as applicable, in its general bearing, now as it was then. “Before cutting, have all your instruments and other things placed ready at hand together—scissors, razor, saw, styptic paste, bleeding-tapes, bandages, pads, tow, eggs, and whatever belongs to the operation—in the same order that one follows the other after the cut.”

Then comes the description of the operation itself—“And when you will cut him, order some one to draw the skin hard up, and then bind the skin with your bleeding-tape tight. Next bind a single tape in front of the other tape, in such a way that a space is left between the two tapes of one finger's breadth, so that you may cut with the razor between them. In this way the cut is quite reliable, goes easily, and makes a perfect stump.”

We notice here an improvement in the drawing up the skin before the incision, with a view to get a covering for the stump. The arrangement of the tapes used for keeping up the skin, and as a guide for the incision, is shewn perfectly in the drawing—the upper tape on the limb above the cut, the lower on the partially amputated part below. Tight as the upper tape may have been applied, it has not been so tight as to make the amputation a bloodless one; for while the surgeon is using the saw, the blood is shewn spouting in several streams from the cut vessels, and a large tub is placed on the floor to receive it.†

* *Feldtbuch der Wundt-Artzney und Chirurgischen Instrumenten warhaftig abcontrafeyt und beschrieben.* Durch M. Hans Gerssdorffen, genannt Schylhans, Bürger und Wundt-Artzt zu Strassburg. Franckfurdt am Mayn, 1551.

† The general character of the drawing, and especially the position of the binding-tapes, lead to the belief that the amputation shewn is one at the lower third of the thigh; if not, it must be one immediately below the knee. The only knife shewn in the illustration of surgical instruments is one nearly of the same shape and construction as a razor of the present time. And in the description of the operation the amputating knife is spoken of as a razor (*schermesser*). But in the drawing of the amputation there is an object on a stool near the operating surgeon which appears like a knife with its blade fixed rigidly in the

Gerssdorff proceeds:—"Now, when you have done the cut, take a saw and separate the bone, and after that undo again the bleeding-tape, and order your assistant to draw the skin over the bone and the flesh, and to hold it hard in front. You should have a bandage ready of two fingers' breadth; it should be moistened beforehand, so as to be wet through—it lies better; then bind the thigh from above downwards to the cut, that the flesh may protrude in front of the bone, and bandage this too. Afterwards lay on the styptic, and you should not have any fear about the bleeding."

"Bind then over the styptic a good thick pad, and afterwards take the bladder of an ox or of a swine—one that is strong—and cut it broad enough to go over the pad and stump. The bladder should be wet, but not too much so. Bind it hard with a tape, and then you ought not to have any anxiety about the bleeding. But if a vessel is obstinate, and will not let itself be stopped from bleeding, cauterise it—that is, burn it with the cautery, the figure of which is shewn on the thirty-third page of the eighth chapter on 'Blood-stopping.'"*

What would be the feelings of one of us if in a case of amputation in one of our wards the femoral vessels were left uncontrolled, excepting by some complicated styptic applied to them, and over it an envelope consisting of a quantity of pads, some impermeable material like bladder, and bandages? What results should we anticipate under such circumstances? Even when the principal vessels are thoroughly secured after an amputation, if bleeding occurs from a small vessel, or only moderate oozing occurs under the flaps, we know that there is only one way of proceeding—to re-open the covered stump, to clear away all clot, to expose the bleeding vessel or surface, and not to cease attention until the bleeding is arrested. How else can a favourable progress be hoped for? But as amputation was ordered to be performed up to, and in the year 1550, not merely vessels of fourth or fifth rate importance, but the primary vessels, were left covered out of sight, with no other safeguard against fatal bleeding than what could be got from styptics and ill-applied pressure. No other conclusion can be arrived at than that, if the means mentioned prevented, in a few instances, death from taking place by primary hæmorrhage, it was only a postponement of the evil day. As a general rule, secondary bleeding, gangrene, or blood-poisoning must have led to fatal results.

The immense, the vital importance of Ambrose Paré's discovery handle. The surgeon is in the act of using the saw, and the word "*Serratura*," in large letters on the picture, shews that the chief purpose of the drawing is to illustrate the mode of using this instrument.

* Five forms of cauterising irons are shewn on this page, with a print of a surgeon applying one to a wound on the thigh of a soldier.

of the use of ligatures in stopping the flow of blood after amputation of limbs may be therefore well understood. The estimate which he himself set upon this innovation in practice does not appear to be an exaggerated one. He felt its value to be so great, that he regarded the thought which had occurred to him as the result of inspiration—that it was taught him by the special favour of God. There were no successive steps in the discovery: it was so simple that it was complete at its first introduction. There was the soft and pliable pipe pouring out the patient's life-blood: a piece of double thread tied round the conduit near its mouth stopped it. Nothing could be plainer or more simple; but plain and simple as it was, it was not till the sixteenth century of the Christian era—not till the year 1552—it was found out, and then the idea of using the ligature probably occurred on the spur of the moment. Paré might well consider it had pleased God to apprise him of it.*

* In the edition of Paré's works of 1552, his second publication, no mention is made of the ligature. In that edition the arrest of hæmorrhage after amputation is directed to be effected by the actual cautery, and a chapter is devoted to a description, with drawings, of the cauteries used for the purpose. This chapter was altogether omitted in the edition of Paré's works of 1564, and the application of the ligature was described in it instead. The omitted chapter on the cauterisation may be seen in Malgaigné's edition of Paré's works, where it is inserted as a footnote.

Paré gives a simple and straightforward account of the origin of his use of the ligature after amputation in the twenty-sixth chapter of the tenth book on "Contusions, Combustions, and Gangrene" (Edit. 1564). The following is an almost literal translation of the passage:—"I advise the young surgeon to follow this my mode of practice, which it has pleased God to apprise me of, without my having ever seen it or heard of its being done by any one. Nor have I read of it, further than Galen writes in the fifth book of his *Method*, that vessels must be tied towards their roots, which are the liver and the heart, in order to staunch a great flow of blood. Now, having used this mode of tying veins and arteries in recent wounds in which there was hæmorrhage, it occurred to me that the same might be done in amputation. Having discussed the point with Estienne de la Riviere, surgeon-in-ordinary of the king, and other sworn surgeons at Paris, and having declared my opinion about it, their advice was that it should be put to the proof on the first patient that offered occasion for it, but that cauteries should be kept all ready for use in case of the ligature not succeeding." And in his *Apologie et Traité, contenant les Voyages faits en Divers Lieux*, under the Voyage de Danvilliers, 1552, Paré refers to the first case in which the use of the ligature in amputation was put to the proof. At the siege of Danvilliers "a culverin shot from the place passed through the tent of Monsieur de Rohan, and struck the leg of one of the gentlemen of his suite. I had in the end to amputate it, and this I did without applying cauteries." And at the end of this section Paré writes:—"The camp being broken up, I returned to Paris with my gentleman, whose leg I had amputated. I dressed him, and God healed him (*ie le pensay, et Dieu le guarist*). I dismissed him to his house, in high spirits, with a wooden leg. He contented himself with his mishap, saying, that he had escaped very cheaply from not having been miserably burned to stop the bleeding." And Paré finishes, with evident glee at the recollection of the case, addressing Gourmelen, the author of the attack against him for using the ligature—"Comme escrivez en vostre liure, mon petit maistre"—"Write this in your book, my little master."

It follows from this history that the application of the ligature in amputation

His directions are to draw out the vessels with a pair of forceps, and to tie them with strong double thread. If bleeding should return after this, then the vessels, with some of the surrounding tissues, are to be included in a ligature, passed through the skin, and tied round them.

Paré also appears to have been the first to direct attention to means of preventing loss of blood *during* the amputation. He states that the band tied round the limb before the operation should be tied tight enough, not merely to benumb the parts, but also to prevent hæmorrhage by pressing and shutting up the veins and arteries. Gerssdorff makes no allusion to this purpose being served by the band, but assigns other reasons for its use, and the drawing of amputation in his book shews that arrest of the flow of blood was not contemplated by it.

The very simplicity of the new mode introduced by Ambrose Paré, for arresting hæmorrhage after amputation, seems to have proved adverse to its general adoption. Not only was the plan not adopted by some of his cotemporaries, but writings which are still preserved shew that some of them were so prejudiced against it, that they treated it with ridicule and abuse, and actively opposed its adoption. The last work that Paré wrote was a defence against an attack on him for having adopted the plan of ligaturing vessels after amputation, instead of applying cauterisation.* It seems probable, indeed, that if it had not been for Paré's social influence, notwithstanding his vast experience gained in repeated campaigns, and his great general professional acquirements, the practical

occurred in the same year in which Paré's second edition was published, 1552, probably not long after its publication.

Paré might have referred to a date antecedent to that of Galen for the use of ligatures to stop bleeding from vessels opened in ordinary incised and stabbing wounds. Celsus gives distinct instructions that, simpler means failing, the vessels should be ligatured in stabbing wounds accompanied with hæmorrhage. His first treatment is to stuff the wound with dry lint, to put over this a sponge which has been dipped in cold water. Pressure is to be made on this by the hand, and the plug of lint is to be changed from time to time if necessary. If this do not succeed, lint wet with vinegar is to be stuffed into the wound. If this do not answer, he says, "The veins which pour forth the blood are to be caught hold of, and near the point which has been stabbed they are to be tied in two places, and are to be cut between the ligatures, in order that they may both retire into themselves, and none the less have their orifices close shut up" (*Venæ, quæ sanguinem fundunt, apprehendendæ, circæque id, quod ictum est, duobus locis deligandæ intercidendæ que sunt, ut et in se ipsæ cocant, et nihilominus ora præclusa habeant.*—*A. Corn. Celsi Medicinæ, Lib. v., Art. xxvi. Par. 21*). Cauterising by a hot iron is to follow the ligature in case of bleeding still continuing. This passage of Celsus has always made it appear the more strange that the idea of applying ligatures to the ends of vessels exposed by amputation should not have occurred to any surgeon before Ambrose Paré; but it is to be explained, perhaps, by the fact that the only amputations attempted in early days were those for removing limbs in a state of gangrene.

* *Apologie, &c.* Edit. Malgaigne. Vol. iii., p. 677.

application of the ligature for stopping hæmorrhage after amputation might have been postponed for a still longer time, through the opposition raised against it by the surgeons of that period. Paré, however, was not only a surgeon of most extended military experience, but he had great power through his court influence. He was the confidential surgeon of four successive French monarchs. It has been recorded that he was the only man of the Protestant form of religion in Paris who was spared at the great massacre of St. Bartholomew, and he only escaped, it is said, by the king shutting him up in his own apartments.* We cannot understand the opposition made to Paré's discovery by some of the surgeons of his day; but we should not censure them too severely. Habits of thought and practice, transmitted to men from bygone times, and continued by themselves for many years, do not readily give place to new notions and ways, however much more true and advantageous they may really be. When I was a student at Guy's Hospital, there was still a physician there who, to ridicule the stethoscope, carried one about with some flowers in it; he used it as a bouquet-holder. To him it appeared to be a new-fangled professional toy.

Paré seems to have anticipated that his new method of arresting hæmorrhage after amputation would not be readily adopted. He thought it necessary to argue at some length in its favour. He called to mind the great and tormenting pain resulting from the application of hot irons and caustic compounds to the exquisitely sensitive surfaces of fresh wounds in the sound flesh—the dreadful symptoms, the convulsions, and fatal results by which the treatment was frequently followed—the frequent recurrence of hæmorrhage when the eschars came away; and he confessed that, having followed this treatment himself, as he had been taught to do, he could now only think upon his having done so with shame and great horror. "Wherefore," he says, "I earnestly entreat all young chirurgeons to leave this cruel and inhuman way, and rather to follow this my manner of practice" (Book x., chap. 26). He mentions that when he first adopted the use of the ligature, he had his hot irons all in readiness, in case of the ligature failing; but there was no need for their use.

Paré's anticipations that the force of long-prevailing custom would

* Malgaigne (see his Introduction to Paré's Works, p. 278) disputes the correctness of this statement, and even throws a doubt on Paré having been a Huguenot at all. The arguments which he adduces to support his views hardly appear sufficiently cogent to destroy the direct assertions in Sully's *Memoirs*, and by Brantôme as to Paré's Protestantism, and his being specially excepted from the massacre by the interference of the king. The statements were written so comparatively close to the period of the great event, that their incorrectness would have certainly been exposed by some one, had they not been founded on truth. On the contrary, their truth was universally admitted until the doubt cast upon them by Malgaigne.

prevent surgeons from adopting the use of his plan of arresting hæmorrhage, seem certainly to have been confirmed as regards our own country. One of the most experienced surgeons, and one holding the most influential position in England, at the beginning of the sixteenth century, was John Woodall. In 1589, he went to France as a young surgeon with some troops which were sent by Queen Elizabeth to the assistance of Henry IV. He mentions, in his writings, that he spent several years in travelling in France, Germany, Polonia, and other foreign countries, in order to gain knowledge and experience in his profession. Subsequently he settled in London, and distinguished himself in the treatment of a great outbreak of the Plague in the reign of King James I. In 1613, he became Surgeon-General of the East India Company, and had the appointment of all surgeons and direction of all surgical matters, both for the sea and land service of the Company. Shortly afterwards, in 1615, he was made one of the surgeons of St. Bartholomew's Hospital. He was holding these two appointments when he published a revised edition of his various treatises in 1639. In this edition, which is dedicated to King Charles I., "as a poor expression of his duty and zeale, for the use of his Majestie's service upon all military occasions for surgerie either by land or sea," occurs a separate treatise on "Sphacelus and on Amputating or Dismembering of any Member in the Mortified Part." The purpose of this treatise is to advocate the amputation being made wholly through the dead tissnes, so that there may be no hæmorrhage nor pain. The division of the putrid parts is to be made about one inch full from the quick part; the surgeon is not to touch any quick part at all with his sharp instruments; to be sure that the part he incises is insensible, he is to inquire cautiously with a needle. Here, then, is a surgeon of one of our largest London hospitals going back beyond the time of Celsus to the practice of the time of Hippocrates. The insensible sloughs remaining on the face of the stump are to be removed at leisure by scissors, by cauterising, and various applications.

Woodall says that in his early practice at Bartholomew's he, with the rest of the surgeons, his partners, acting on tradition, had amputated in the sound parts; "but the horrid paine the patient thereby susteineth, with also the great uncertainty of his life after his extreme sufferings, caused me ever to mislike my own workes therein."* He then conceived the idea that he might in

* As Woodall mentions that he had studied in France in his younger days, he could not but have become acquainted with Paré's method of ligaturing blood-vessels after amputation of limbs; and in some remarks on "Dismembering or Amputation," in his first published work, the *Surgeon's Mate*, he refers to it.

some cases save a man's life by amputating in the sphacelated part; and about the year 1617, he tried this mode on a patient who had a mortified leg, and who was so weak that he was sure he would die under the operation from pain and loss of blood, if he amputated in the sound parts. The operation succeeded, and ten weeks afterwards he left the hospital in good health, walking on a wooden leg. From that time Woodall only amputated through the mortified parts; "so that," to use his own words, "where the complaint formerly was, that by reason of great hæmorrhage—namely, the large effusion of blood and spirits in the worke of their amputations—many of their patients perished under the surgeon's hands in the very act of amputation, I may, to God's glory, and justly doe affirme for a truth, that for the space of nere twenty-four yeares I have been a surgeon in the Hospitall of Saint Bartholomewes, where I have taken off, and holpen to take off many more than one hundred of legges and armes, besides very many hands and fingers, amongst all which not one of them all hath dyed in the time of their dismembering nor afterwards through the exceeding effusion of blood; and furthermore, I affirme that not above foure of each twenty dismembered but lived to have been healed, notwithstanding whatsoever their diseases have been" (Woodall, Edit. 1639, p. 388).

Let us see what influence Paré's discovery exerted at a still later period in England; and for this purpose I will quote the instructions given for performing an amputation by one of the most experienced, shrewd, and practical military surgeons our country has ever known—viz., Wiseman, the Paré of England, as he has been called. The writings of Wiseman may be referred to now by all military surgeons with advantage. They abound with records of cases of gunshot and other injuries, which are related with remarkable accuracy, and the observations upon them are so judicious and practical, that no surgeon can fail to be interested in them, or can study them without benefit. He gained great experience, and distinguished himself as a surgeon, throughout the Civil Wars

He only mentions the practice, however, in regard to amputations above the knee, and then evidently anticipates that a surgeon will meet great difficulty in applying it. "Note further, that if the legge be taken off above the knee, there is the more danger, also there is great care to be had to the great veine and artery—namely, that thou take them up, and pierce them thorow, and make strong ligature about them, which must be speedily done, if thou canst do it; but at first, I fear, thou wilt misse; yet be not discouraged, nor stand too fast to seek them." (Chapter—"Of Wounds and their Cure," Section—"Of Dismembering or Amputation." Edit. 1639, p. 159.) In amputations in general, Woodall recommends strong restrictive powders, vitriol, alum, &c., being applied to the vessels and stump, together with tight bandaging, for checking hæmorrhage—indeed, he adopts very much the same plan of treatment as Gerssdorff. Evidently, from Dr. Woodall's remarks on it, amputation was regarded at the time as a most formidable operation.

under Charles I. He afterwards was with Charles II. during his exile in France, Flanders, and Holland. Then he served as a surgeon in the navy under the Spanish Government. He again joined the Royal forces in England, and was made a prisoner at the battle of Worcester. He settled in London in 1652, and after the Restoration was made Serjeant-Surgeon to the King, which appointment he also held in the reign of James II. He first published his professional observations, under the title of *Several Chirurgical Treatises*, in 1676. His works were reprinted in 1686 and 1705. It is from the latter edition, published sixty-six years after the treatise of Woodall from which I just now quoted, that I will take Wiseman's remarks on the operation of amputation.

It has been stated that Petit, in France, the inventor of the tourniquet, was one of the first surgeons to advocate the propriety of primary amputation for gunshot wounds. This remark could never have been made by any one who was acquainted with Wiseman's works. That the necessity of early amputation in certain gunshot wounds was well-known to Wiseman, is not only evident from cases related or alluded to by him, but it is distinctly mentioned by him in the first paragraph which I am going to quote. He gives besides a list of the wounds in which amputation is necessary. His remarks on the mode of amputation occur in his chapter "of Gangrene and Sphacelus," and he thus introduces them:—

"But since not only in this chapter of gangrene, but frequently elsewhere in this book, we have mentioned amputation, I think it necessary to take this occasion to shew the manner of performing it; the rather, because the operation is much the same, whether it be done on account of gangrene or for other reasons."

"In heat of fight, whether it be at sea or land, the chirurgeon ought to consider at the first dressing" (obviously this means when the case is first brought to the notice of the surgeon) "what possibility there is of preserving the *wounded member*; and accordingly, if there be no hopes of saving it, to make his amputation at that instant while the patient is free of fever," &c.

Then follow his remarks on the kinds of gunshot wounds for which amputation is required. Nothing can be more judicious than his observations on this subject; but they are given at too great a length for me to quote them. Excepting that he regards penetrating wounds of joints by bullets as requiring amputation in every instance, the proceeding of resecting joints being then unknown, the most practised surgeon of the present day could hardly improve on the directions given by Wiseman on this particular point.

Wiseman thus begins his account of performing the amputation on a patient:—"Seat him so as it may be for your conveniency. At sea they sit or lie, I never took much notice which, nor do I

remember I had ever anybody to hold them; but with the help of my mates, and some one or two that belonged to the hold, I went on with my work. At Sterling I made an amputation above the knee, and had as little help; besides my servants, there was only a sea chirurgeon assisting me. We stopt the flux of blood by actual cautery, and the wound digested and cured without any ill accident. Yet, when we have convenience to proceed more formally, we always place the patient to our most advantage, where he may be held firm, and in a clear light, and so that our assistants may come better about us. The member is to be supported by some one, while another standeth behind the patient and draweth up the skin and musculous flesh."

In the next paragraph Wiseman dwells at some length on the importance of the band placed on the limb before amputating, such as is described by Gerssdorff, and is shewn in the woodcut on amputation in his book. But you will notice that instead of merely using it for keeping the skin drawn up, and as a guide to the line of incision, according to Gerssdorff's directions, Wiseman considers its value to be its action as a ligature and preventive of hæmorrhage during the performance of the amputation—the necessity for which Ambrose Paré, as already mentioned, first indicated.

Wiseman proceeds:—"Then make your ligature two fingers' breadth or thereabouts in the sound part; so that if you amputate in case of mortification, you may be sure to quit yourself of it. This ligature is omitted by many of our chirurgeons here in this city, they only making a turn with a tape, pinning it on as a mark to circumscribe by; and instead of the ligature I propose, they make a gripe, which gripe is commonly made by an assistant who has strength to do it. In amputations this seems to me to be very inconvenient; for I never yet saw any man so gripe, but that still the artery bled with a greater force than was allowable—yea, when Mr. Woodall griped, who was so applauded, and in truth made for the work. It being so, in what a huddle is the stump then drest? But suppose the uneasy posture and the long griping tires the griper, or that his hand be cramped the while, what condition is the patient then in? Whereas by this ancient way of ligature the vessels are secured from bleeding, the member benumbed, and the flesh held steady, ready to receive the impression of your crooked knife (or razor, which I have often amputated with)."

How plainly does the whole of this description shew the importance of the subsequent invention of the tourniquet—an instrument to which we have always been so accustomed—and a contrivance again so simple, that without the attention being

drawn to such a discussion as that which Wiseman has entered upon in the paragraph I have quoted, one might almost take for granted tourniquets had existed as long as amputation itself for preventing hæmorrhage during the operation, no less than we might have done, without corresponding inquiries, in respect to tying the divided and bleeding vessels after the operation had been performed.

"This ligature made," continues Wiseman, "the assistant strengthens it, whilst he draws up the muscular flesh. In the meantime the operator, with a sharp crooked knife, by a turn with his hand, cuts the flesh off round to the bone; then with the back of it he scrapes the periosteum from the bone; if there be two bones, then with a dividing knife he separates the fleshy membrane from them."

Wiseman does not think the linen retractor proposed by Guido necessary—"the parts," he says, "separate enough of themselves; besides, the assistant pulling up the muscular flesh and skin is sufficient to make room for the saw."

Now comes the manner of stopping the flow of blood from the divided vessels after the amputation. About one hundred and fifty years had now elapsed since Ambrose Paré had introduced the plan of ligaturing the great vessels, which is so familiar to us all, which Paré's previous experience led him to think an improvement of such vital importance, that he attributed the happy thought to Divine inspiration; and yet we find such a practical surgeon as Wiseman regarding it as too intricate a proceeding for ordinary use in great emergencies—as no better, as, indeed, practically inferior to the actual cautery, and as not likely to hold its ground in consequence of the superior advantages of a newly invented styptic. The ideas of the very oldest surgeons were thus maintaining their influence over the operative proceedings of the greatest surgeon of his time—a time comparatively so near to us as the beginning of the last century. Wiseman makes a strange mistake in attributing the invention of drawing out the end of the bleeding vessel and ligaturing it to a German surgeon, Fabricius Hildanus, whose works were not published until 1641, fifty years after Ambrose Paré's death; while to Paré himself he gives only the credit of inventing a simpler plan than that of securing the vessels by the process of ligature—viz., the plan of passing a thread through the skin near the vessels, then under the vessels, then through the skin again on the other side, and thus compressing the vessels in very much the same way as is done in one of the forms of acupuncture. Really Paré only suggested this method in case of the ligature of the vessel itself failing from some cause, and hæmorrhage recurring in consequence.

Wiseman's directions for the suppression of bleeding in amputation after sawing through the bone, are the following:—

"You are at liberty, whether you will cauterise the vessels by a bntton cautery, or by ligature stop the bleeding, or by agglutination. The use of *chalcanthum*" (copperas) "I do not approve. To apply escharotics to the ends of the nerves and tendons newly incised causes great pain, weakens the part, and makes way for gangrene. The way Hildanus proposes, by drawing out the vessels by a forceps, is not a work to be done in the heat of fight, nor without a clear daylight. If you attempt it on land, his arm should be bowed and his leg stretched out, that the vessels may be the longer after extirpation (*i.e.*, the dismemberment), that you may the better take hold of them. Ambrose Paré proposes a more easy and sure way of deligation, by passing a needle with a strong twisted thread through the skin near the great vessels, making your stitch over the said vessels by piercing through the raw flesh and skin; then make your ligature upon a fold of a rag. Thus you bind the artery and the vein. These several ways have been practised by eminent chirurgeons for the stopping the blood of the arteries in amputation; but the late discovery of the Royal Stiptick hath rendered them of less use. But in heat of fight it will be necessary to have your actual cautery always ready, for that will secure the bleeding arteries in a moment, and fortify the part against the future putrefaction. They require after cauterisation no such strict bandage as that thereby you need to fear interception of the spirits."

Exfoliation of the end of the bone after amputation was evidently regarded by all the old surgeons as part of the process of cure, as much as suppuration and granulation of the soft parts. Wiseman's description shews that he had no idea that it could be prevented, but only that the separation of the dead from the subjacent portion might be hastened. He says, "When we cauterise the artery, we do then touch the end of the bone, it hastening the exfoliation."

He then describes the loosening the bandage round the limb, and bringing the lips as close over the stump as possible. He advocates the use of a cross stitch to keep them approximated. "The most that I have seen without the cross stitch have the next dressing been broad stumps, some of them with lips turned outward by the bandage; in the least of them the whole stump has been bare. . . . The broad stump is a certain sign of a long cure, and commonly the death of the patient." "If the musculous flesh and skin are well pulled up in time of amputation, and brought over by a moderate extension as far as they will easily admit, you will find it not painful. You ought to pierce the skin with a needle and strong brown thread ceared" (waxed thread) "about half an inch from the edges of the lips."

A variety of dressings are to be applied in succession to the stump—restrictives, astringents, defensatives, white of eggs, and others—then an ox bladder, ready cut and wet, as in Gerssdorff's practice, is to be turned over it—a cross cloth next the bladder to keep it steady—and then roller bandages. The dressings are to be taken off the third day, the cross stitches cut, and the wound is to be dressed with astringents, and digestives, stimulating applications, like turpentine and others, to excite suppuration.

It almost makes one shudder, in these days of ether and chloroform and of simple dressings, to think of the torture a patient was still subjected to at this date, when he survived to go through the successive processes which were held to be *secundum artem*, in order to ensure the cicatrisation of a stump after amputation.

Wiseman relates the particulars of some successful amputations which he performed, and which still further exhibit the manner of amputating. The plan of amputation adopted by him has, however, been sufficiently shewn in the quotations I have already given.

Such then was the state of this operation at the beginning of the last century in England. The use of the ligature for stopping hæmorrhage after amputation was known, but was hardly considered more practically useful than cauterisation, which had been in use from the earliest ages; while a new styptic that had been lately discovered was thought likely to supersede both. The mode of performing amputation by flaps was unknown. The circular amputation in use was still made by a straight single incision through all the parts at once. The restrictive applications and bandages to the stump after the operation were voluminous and complicated. The objects of the dressings applied to it were first to prevent bleeding, and then to excite suppuration as freely as possible; the attempt to heal such a wound by simple adhesion had not been thought of. There can be little doubt that under such circumstances the larger amputations were rarely practised, and that when from necessity resorted to, they must still, in a large proportion, have been followed by fatal results.

Although surgeons, as I have shewn, were a long time in appreciating the discovery of the ligature for preventing hæmorrhage at its full value, and overrated the difficulties in employing it, we, looking back, are well able to perceive what a new and vast field it opened for the improvement of surgery. At the best, when large vessels were concerned, the effects of the actual cautery formed but a weak barrier against hæmorrhage, the action of styptics was a slow and most uncertain one, while by means of the ligature the wounded vessel could be securely stopped directly after it had been

divided. The first and greatest danger in the performance of amputation was thus removed as regarded the patient; the greatest source of dread in undertaking it, the most formidable feature in the character of the operation, was removed as regarded the surgeon. But there was one most important improvement still wanting. The safety of the operation had been greatly enhanced by lessening the loss of blood after its performance: could nothing be done still further to lessen its danger in the way of preventing the great loss of blood *during* its performance? It is true that Wiseman and others had employed the bleeding-tape band to this end. To make this band tighter, it was twisted by some surgeons by means of a stick placed between it and the limb, in the same way as a packing stick is sometimes used to tighten the ropes which bind large packages together. I need hardly say how clumsy these proceedings were, and how very imperfectly the object in view could be attained by such methods. The band employed in the way mentioned had no resemblance to the elastic ligature used in the bloodless operations of the present day. The elastic bandage, beginning at the extremity, not only presses back the blood from the capillaries and veins, but also prevents any fresh access of blood to them through the arteries, so that the empty capillaries and veins cannot be refilled. By the time, then, the elastic ligature is applied above the part to be amputated, all the limb below is emptied of its blood, and none can return to it so long as the constricting pressure of the elastic ligature is retained. The bleeding-tape ligature of Wiseman and others did little more than the bleeding tape does in venesection. It produced congestion of the veins of the parts below the tight band, while it failed to stop, though it might lessen, the flow of blood through the deeply situated larger arteries. Notwithstanding the tight band above the line of incision, there was therefore a great loss of blood from the quantity in the gorged limb which had to be amputated, and from the flow of blood while the amputation was in the act of being performed.

It was a French surgeon again who designed a plan of remedying this defect—the great loss of blood during the operation of amputation. In the year 1718, Jean Louis Petit read at the Royal Academy of Sciences at Paris a description of his tourniquet. The instrument was precisely the same in principle as the Petit or screw tourniquet now in use; and when once it was in the hands of surgeons, they had direct command over the flow of blood through the principal arterial trunks of the extremities. With the tourniquet to prevent hæmorrhage, not only during the division of the parts, but also after they were divided, a surgeon could now spare time to search for the bleeding vessels, and to ligature them with confidence; and with hæmorrhage pre-

vented by the ligatures on the vessels, when the screw of the tourniquet was loosened, no fatal loss of blood could occur. The mere operation of removing a limb by amputation was now at last deprived of all its most alarming features. There was no longer the same vital need of performing the amputation hurriedly. Surgeons could now devote attention to considering the most judicious method of performing amputations—the methods which would ensure the most sure and speedy healing of the stumps, and the most serviceable forms of stumps when healed.

The account I have laid before you of the method of performing an amputation, and of dressing the stump, which were in vogue when Wiseman's works were published in the beginning of the last century, will have sufficiently shewn you how many and what serious defects there still remained to be remedied in these proceedings.

In the first place, the only mode of amputating was the circular, and this was done by a single straight cut. It is difficult to define the exact period when attempts were first made to remove the inconveniences which this mode of incision gave rise to. Petit, the inventor of the tourniquet, has usually the credit of having first performed a circular amputation by two incisions; the first incision being limited to the skin, and the second being made through the muscles after the skin had retracted, or had been further released and drawn back by the hand of the operator. It is exceedingly likely that Petit was the originator of this plan, for the application of the tourniquet, by leaving the parts near the seat of the division exposed, easily admitted of the improvement being made, while it could hardly be done when the band was employed in the manner described by previous surgeons. Another French surgeon, Louis, noticing the unequal retraction of the different layers of muscles, has the credit of still further improving upon this plan, by making the first incision divide the skin and superficial muscles, the second incision the deep muscles. Reference to the works of British surgeons, during the latter part of the last and the beginning of the present century, shew that they made great efforts to preserve integuments enough for covering the whole stump; and to assist in this object the rule in circular amputations gradually came to be, after full retraction of the skin, to make as many separate incisions through the muscles as there might be muscular layers.

I have not been able to satisfy myself as to who was the originator of the plan of performing amputation by flaps. Surgeons must have observed and treated accidental injuries in which the only covering for the exposed wound would be a flap. An arm torn from its socket would, probably, leave only such a covering

available. The difficulty of amputating at certain parts of the leg by the circular method would, probably, suggest a flap operation, when once the control of hæmorrhage by the tourniquet and ligature allowed the surgeon to give time and attention to modifying the shape of the covering for the stump.

It is hardly the purpose of my remarks, however, to follow all the successive alterations in the details of the method of amputating, nor have I time to do so. When once the flap mode of operating was added to the circular method, it is easy to see that different shapes and fashions would be successively introduced, according to the views of different surgeons and the exigencies of particular cases. The oval flaps, the anterior and posterior flaps, the lateral flaps, the short and long rectilinear flaps of Teale, the skin flaps of Syme and Carden, have all particular merits in particular instances; and it would be only in considering amputations separately that their respective merits could be adequately estimated.

There was, however, another improvement of great value, and one of a more general character, which the invention of the ligature and the subsequent changes I have noticed paved the way for, and which I must just mention before closing this historical account of amputation. This was the opportunity they gave for the greater part of the stump being permitted to become healed by first intention, instead of by exfoliation of bone, and by "digestion, mundification, carnification, and cicatrisation" of the soft parts, to use the old terms. So long as the face of the stump had to be plastered over with clods of styptic paste, pads, and other coverings, sometimes in addition to previous cauterisation, I need hardly remark, immediate union was out of the question; and even long after the introduction of the ligature, until the use of the tourniquet, placed at a distance from the seat of amputation, rendered it possible to get skin enough for completely covering the whole face of the stump, union by first intention was still an impossible result. When once the only foreign substances necessarily left in the wound were portions of the slender artery ligatures, and when once the importance of preserving a complete covering for the whole stump was properly appreciated, and the means of leaving sufficient covering for this purpose were quite understood, then healing of the general face of the stump became possible. But though possible, it is not likely that the desirable result was ever attained until very recent years; for the fashion of applying various kinds of dressings between the face of the stump and its natural coverings, whether circular or flap, still maintained its sway. The thoughtful observations of John Hunter on the union of cut surfaces by the adhesive process, and the influence of his teaching and writings, disturbed the pre-

vailing faith in the necessity for these artificial complications of the existing wound. Then the practical experience of the Peninsular War, especially the introduction of simple water-dressing by moistened lint, and the omission of the irritating applications previously in vogue to the raw surfaces of the stumps, removed most of the remaining difficulties in the way of achieving union by first intention. At the same time a gradually acquired better appreciation of the importance of hygiene in surgical treatment of cases, of the essential need of atmospheric purity and local cleanliness, with more judicious constitutional treatment, not merely contributed towards lessening the mortality after amputation, but also caused the healing process to advance more evenly and surely towards the desired cure.

Even in the present day, however, it can hardly be said that surgeons are agreed on the means necessary for obtaining primary union in amputations and other similarly large incised wounds. A large body of modern surgeons follow the same path of improvement that the historical summary I have been laying before you has disclosed to your view. You must have noticed that the chief features of the history have been, on the one hand, a gradual elimination of a variety of things introduced through ignorance, which impeded repair—that is, of things which interfered locally with the simple processes of Nature for securing a speedy restoration of union in the divided structures; and, on the other, progressive acquirement of a more accurate knowledge of the general conditions under which patients who have suffered amputation should be placed, in order that Nature may the more easily carry on these her healing operations. Some surgeons are still trying to act under the guidance of these principles, and these principles only. They may be classed as belonging to the “Natural School.”

Another body of surgeons, at the head of whom is Professor Lister, assert that there are unavoidable impediments to simple healing, to union by the adhesive process, under this natural method. Their observations lead them to believe that the atmosphere is loaded with germs—organised ferments—which cannot, under ordinary dressings, be prevented from reaching the exposed wound surfaces, and that when they do reach them, putrescence and suppurative action must follow. From this belief it follows, as a matter of course, that such dressings must be applied to the raw surfaces as will either intercept these germs on their way, or render them inert in case of their reaching the cut surfaces. The surgeons adopting these views, and the practice founded upon them, belong to the “Antiseptic School,” and their treatment of wounds is known as the antiseptic treatment.

Both on the Continent and in England, surgeons of the

present day in their treatment of large wounds, are seen to be ranging themselves under the banner of one or other of these two schools. The theories and practice of the two schools form a wide subject, which cannot be discussed in a summary manner. At any rate, I may be allowed to say, while acknowledging the very remarkable cures which have been effected under the antiseptic method of treatment, that the natural process of treatment has been attended with very successful results also. And as a military surgeon, I should regard with much sorrow the fact, if it could be established as a fact, that the antiseptic treatment of wounds, in its strict integrity, is absolutely essential for ensuring a favourable process of cure in extensive wounds; for, if it were so, this favourable process of cure could only be obtained under very rare and exceptional circumstances in the wounds which military surgeons have to deal with on a large scale in time of war. The circumstances under which the wounds are contracted, and the conditions in which soldiers are usually placed for considerable periods after their infliction, must always render attempts to carry out the antiseptic treatment of wounds in its integrity altogether nugatory.

I have now concluded my historical summary of the operation of amputation, but before finishing the lecture, I will make a few remarks on its manual performance. One of my first observations was, that the amputation of a limb is one among the plainest and simplest operations that a surgeon is called upon to perform. The rules for amputating in different portions of the extremities are laid down in surgical works in the most precise manner. Measurements and drawings accompany these descriptions, which leave nothing to be desired in these respects. Even what may be called various styles of amputating are at your disposal, and you have only to make your choice as taste or judgment may dictate.

Yet simple as the operation appears to be, and precise as the rules are which may be learned regarding it, you may depend upon it that there is only one thing which will enable you to perform it in the manner in which it should be performed, and that is, practice upon the dead body. If you have not acquired the manual dexterity which practice affords, some of you may find yourselves, under the excitement of great emergencies, making terrible blunders. No doubt, living textures act differently under division by incision from what the same textures do when they have lost vitality. Practical acquaintance with the differences between amputating through living and dead parts can only be acquired by operating on the living; but there must be a beginning to this practice, and it is as a preparation for this beginning that practice upon the dead body is of such great importance. The performance of operations on the

dead body trains the eye as well as the hand. Nothing is more painful to behold than a patient in the hands of an operator whose incisions are made in a hesitating uncertain way—nothing more embarrassing than after amputation to see the coverings of the stump left too short, or left so long that fresh cuts have to be made to shorten them. Practice on the dead body will teach how these bungling errors are to be avoided. But worse mistakes than these occur when amputations are undertaken without that amount of familiarity with the operation which may be gained by practice on the dead body. We have here a book of original sketches, by Sir C. Bell, of cases which he observed after the battle of Waterloo. One of the earliest sketches is that of a French soldier who had undergone amputation of the thigh at the junction of the upper and middle third. In this instance no skin or flaps whatever have been left as a covering for the face of the stump. A large mass of charpie had been put over the amputated surface. This had been taken off when Sir C. Bell made his sketch, on account of oozing of blood. The surgeon-artist has written a few observations under his drawing. This is a portion of them:—"This is a Frenchman, (thigh) amputated on the field. The stump bleeding, it was necessary to open the wound; but it was open, and, under the rags, only this (A) clotted mass of charpie on the face of the stump. The wretched man understands a great deal. He keeps his thumb fixed on the compress over the artery; he says that the artery was tied, but 'qu' il est tombé.' Here is an hospital mate, who says, 'Well, they cut them like a round of beef.' The limb is directly off, and the whole on the same level, the bone projecting, the skin not retracted," &c. From these remarks we must infer that this was not the only instance in which the operation was performed in the manner shewn in the drawing. The operators, so far as concerned the mode of incision, might have lived in the days of Celsus.

An amputation made in the Crimea was mentioned to me, in which the operator, from taking up a wrong position in regard to the patient, and from confused and bungling inadvertence, amputated the patient from the limb instead of the limb from the patient. The flaps were on the shattered extremity, the raw surfaces exposed by their removal on the part of the limb intended to be preserved. The mistake was only discovered when the saw was about to be used.

But let me quote a more recent and more surprising case to you, one that occurred at Paris during the late siege, in the spring of 1871. It is an instructive case in more than one respect. The account of it admits of no doubt as regards any of its particulars, for it has been related by my friend, Inspector-General Chenu, whose fame, on account of his most valuable medico-military

statistics and histories of French campaigns, is world-wide, and whom I know to be as honest and fearless a military surgeon as has ever lived. I will translate Dr. Chenu's remarks literally* :—
"François C——, *Æt.* twenty-seven years, a strong carman, acting as a gunner at Fort d'Issy, was wounded on the 28th April, 1871. A large fragment of shell almost entirely carried away the left leg; it remained attached to the rest of the limb by a few strips of flesh only. The surgeon on duty at the fort decided to amputate immediately. Having, no doubt, but little practice in this kind of operative proceeding, he set to work to cut off the thigh above the lower third, and made with his knife a curvilinear incision more than fifteen centimetres in length; then, finding probably that he was amputating too high, the surgeon (can one give this name to such an operator?) stopped, replaced his knife lower down, and with one single circular cut divided all the tissues of the thigh just above the patella without making any flaps. He now sawed through the femur obliquely through the middle of the condyles. No ligature was applied."

"The patient who had undergone this double amputation of the thigh at eleven o'clock in the morning, could not be removed to our ambulance of the Cours-la-Reine until after six o'clock in the evening. The pupil who received the wounded man, after having undone the dressing and cleared away a considerable clot, was extremely astonished not to find in this large gaping wound any ligature thread. He looked attentively, and cautiously separating the tissues glued together by a large quantity of recent plastic lymph, he recognised the section of the vein and the popliteal artery. The mouth of this latter vessel was scarcely at all narrowed, but was almost entirely closed by the folding or knitting together of the internal coats, which appeared to be turned round upon themselves inwards. A ligature thread was immediately placed on the artery, and an alcoholised water-dressing applied to the stump."

"When I saw the patient the following morning, 29th April, I ascertained that the semi-circular incision by which the surgeon had wished to commence his first amputation reached as far as the muscles on the antero-internal aspect of the thigh—a suture kept the edges in imperfect apposition. As to the raw surface of the stump, it was hideous, for the operator, taking no care to follow the rules of operating, had neglected to make even the smallest flap; the section of the skin, flesh, condyles of the femur, had all been made on one inclined plane from above to behind, in such a way that the front skin of the knee, serving solely for an incomplete flap, leaned upon the anterior bony edge left by the section of the condyles; in a word, the ablation of the limb had been performed at the level of the knee, without flap and without ligature of any

* Chenu, *Guerre de 1870-71*, tome 1er, p. 296.

vessel. The wounded man subsequently suffered from chronic purulent infection, but did not succumb till nearly two months after his admission."

Can you have a more complete, and, at the same time, a more shocking illustration of the sad results which may follow the attempt to perform even so comparatively simple an operation as an amputation at the lower part of the thigh, when the operator has not been rendered familiar with the mode of performing it by previous practical study on the dead body? How many patients on whom such an atrocious amputation had been performed, would have survived for anything to be known about it? That the patient did survive in this instance, Dr. Chenu attributes in the first instance to the general state of syncope of the patient, to the local inaction of the parts which had been successively subjected to such severe injuries, but especially to the retraction, or rather shrivelling up of the two internal coats at the mouth of the principal vessel.

Let me then advise you to neglect no opportunity you can get of practising the performance of operations on the dead body. We have not quite so many opportunities here as might be wished; but I hope you will feel the importance of making full use of those that do occur, so far as the time at your disposal from other work will allow. You will find that opportunities of such practice will rarely occur in your subsequent career in the public service, unless you strive very earnestly and perseveringly after them. There are still great prejudices against the use of the bodies of the dead for the practice of surgical operations. The objections raised against it are almost as irresistible as they are inconsistent. It is a matter in which the public at large, as well as most of the individuals composing it, act very unfairly, it seems to me, against the members of our profession. On the one hand, they expect every surgeon to be a skilled practical operator; on the other, they do little to help, they too often throw impediments in the way of his having the opportunity of becoming one. There is still much of the same feeling existing which was sanctioned, and, indeed, enforced by law previous to the passing of the Anatomy Act in 1832; for, before that Act was passed, though the Medical Colleges held teaching anatomy by dissection to be imperative, legally it was impracticable. The law made it a punishable offence for any surgeon, for any lecturer on anatomy even, to retain a human body for dissection, unless it was the body of a murderer who had been executed. Perhaps some of the feelings of disgrace and crime which were thus caused to be associated with the use of the dead for dissection still cling to society in general. Fortunately, among military men, and especially among military men in time of war, there is not the same strong objection against the utilisation of the bodies of the

dead for the practice of surgical operations. They are conscious how closely their own personal interests may be involved in the proceedings. They cannot tell, particularly when battles are imminent, how soon their own turn may come to fall under the surgeon's knife, and they perceive the advantages of the practice. Larrey in the histories of his campaigns, frequently refers to the army surgeons being assembled, and, either under his own direction, or under that of other experienced officers, taking steps to improve their acquaintance with operative surgery by practice on the dead. The custom is one which might well be enforced in all army regulations.

During the comparatively recent great war of the Rebellion in the United States, special operating surgeons of known competency with experienced assistants were appointed, irrespective of military rank, in the several army divisions of the Northern armies. During the still more recent Franco-German War, the most eminent surgeons engaged in civil hospital practice, men of the widest European reputation—such as Stromeyer, Langenbeck, Bardeleben, Nussbaum, and others—were attached to the German armies as consulting surgeons. These last were not appointed to act as operators unless requested: they were present to advise only in difficult cases. The arrangement seems to have created a good deal of jealous feeling in the minds of the army surgeons generally. I confess I cannot find any solid ground for the objections raised against the arrangement. No one can doubt that there are very different degrees of ability and expertness among surgeons as operators, and very different degrees of knowledge respecting the proper surgical proceedings to be adopted in particular cases of injury, any more than one can doubt that there are very different opportunities and ranges of surgical practice and surgical experience among surgeons. No surgeon need or ought to feel shame, if a more experienced and more skilful operator than himself be present, in giving up the knife to him. It is life which is at stake, or very often, if not life, the preservation of such ability to use or enjoy life as makes life of value. The interests of the patient are surely to be first considered. Not long since a case of hæmorrhage after a wound of the face occurred in our own service in the field, where the loss of blood was threatening to kill the patient speedily. The only operation that appeared capable of saving the patient's life was ligature of the common carotid artery. The surgeon under whose care the patient fell in the regular order of practice was not familiar with the operation, though, no doubt, aware of its delicacy—he had probably never had any opportunity of seeing it done on the living, nor for a long time of practising it on the dead body; but another surgeon who came by had the operation, as the saying is, at his fingers' ends. The surgeon in

direct charge of the patient let the experienced operator do what was necessary. So far from deserving obloquy, he seems to me to have deserved praise for thus acting : he would rather have deserved blame had he operated under the circumstances. A surgeon who has a patient's interest at heart will be glad of the opportunity of consulting with surgeons of wider experience than himself respecting the patient's case and its treatment ; and when manual proceedings are required, will be glad to avail himself of the assistance of one whose greater practice and experience have rendered him more expert and dexterous in them. It is especially incumbent on military surgeons, who must frequently be placed in situations where no such counsel or help is available, to take advantage of every opportunity that is afforded to them of acquiring practical acquaintance with operative surgery. If a military surgeon have to perform an operation, and he feels himself unable to undertake it, or, undertaking it, performs it in some reprehensible way, even though far less so than occurred in some of the examples I have brought to your notice, and he is at the same time conscious that his want of skill is due to neglected opportunities of practice, then, indeed, he must feel shame, and justly ought to feel it. I trust this may never happen to any one of you whom I am now addressing. I trust you may prove yourselves competent operators whenever and wherever your services are required. I entertain this hope, no less for your own peace of mind and comfort, than I do for the sake of your patients and the interests of the public service.

